HADES v1.0
Installation Guide v0.9

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Authors:	Roland Karch, Andres Guerrero

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1 Introduction

The DFN-LAB has developed a system called HADES (HADES Active Delay Evaluation System). HADES is a tool that provides performance measurements following the IETF approach [RFC3393] and offers IPPM performance metrics such as One-Way Delay (OWD) [1], One-Way Delay Variation (OWDV) and Packet Loss. A transmitter station produces groups of UDP-packets (UDP: User Datagram Protocol) in configurable intervals, signs each packet with a valid timestamp (based on a GPS hardware clock) and a sequence number and transfers it to a receiving station. The receiver determines precisely the actual receiving time and stores all the data in a file. With this information the one-way delay, the delay variation and packet loss on a single route can be determined.

HADES is currently being used for all IP performance measurements at over 57 locations within the X-WiN (the German R&E Network). HADES measurements are currently also being performed within GÉANT, within the LHCOPN networks (Large Hadron Collider, CERN) and within NRENs participating in the GÉANT2 MDM Prototype resulting in more than 100 measurement stations being deployed worldwide yielding data on over 5000 monitored paths. Access to the HADES measurement data is available through the perfSONAR-UI graphical interface (http://www.perfsonar.net/).The purpose of this document is to provide a guide on how to properly install HADES. During the installation process, this guide should be used together with the HADES User's Guide [2], which focuses primarily on the steps required to install and start HADES in an environment mainly based on two (or more) points of measurement and a central server. Because of this distribution, the process presented here involves the manipulation of both a server system and client stations that are in charge of measuring the network.

This document is organized as follows: Chapter 2 is about the HADES architecture and the hardware environment which this installation process uses. Subsequently, sections 3.1 and 3.2 in Chapter 3 focus on the requirements for the installation of HADES. Chapter 4 gives an idea about what steps are useful to do before the installation process of HADES begins. Chapter 5 describes the installation process itself, and finally, Chapters 6 and 7 are related to post-installation steps of HADES.

2 Architecture

The HADES architecture is described by the modules listed in figure 2.1. Several main parts can be identified: The blue box on the left represents a measuring station, set up by a receiver process. As part of the outcome 'raw data' text files are produced, which contain the measurements (timestamps) made by the terminals. In the middle there is the central server using the script "hades-analyzer.pl" to perform, among other tasks, the analysis of raw data. As part of this analysis an aggregated representation of the raw data is generated with different measures such as the time taken by the fastest/slowest package, the amount of lost packages, etc.

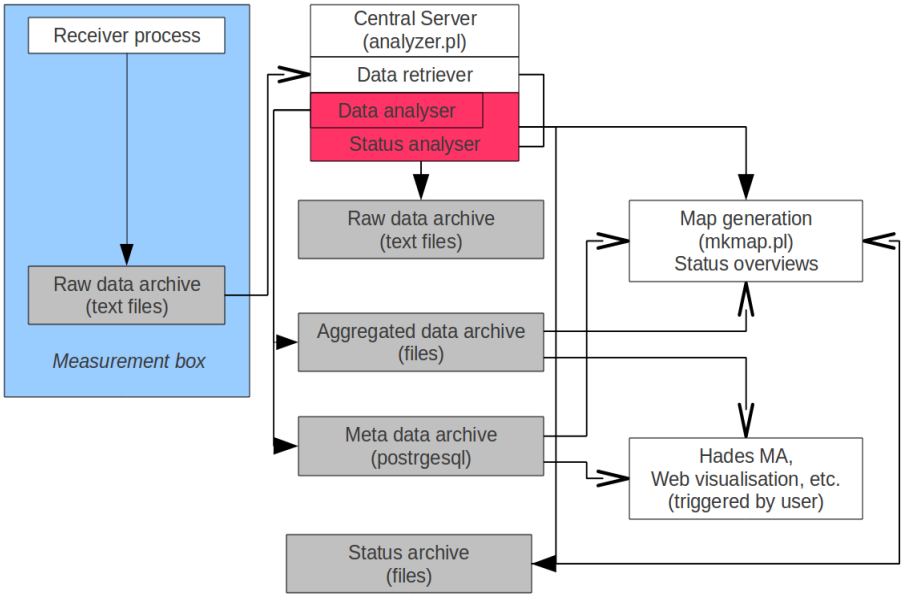

Figure 2.1: The different modules of the HADES architecture

On the right side of the figure there are two visualization modules. The upper module called 'Map generation' is responsible for the generation of maps that characterize the different paths based on the measurements previously obtained. The bottom module described as 'HADES MA' (Measurement Archive) is responsible for the web visualization.

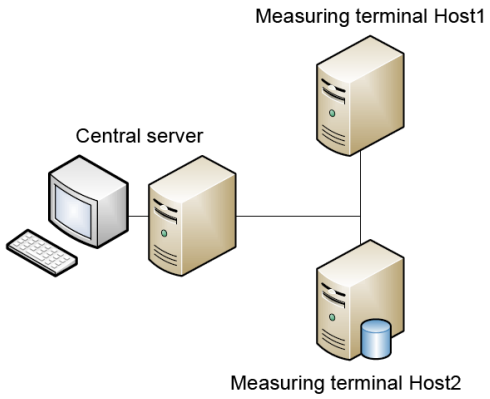

Figure 2.2: Basic structure of HADES

Figure 2.2 shows the basic structure of HADES that this installation process uses. Here the reader can see two HADES measuring stations (Host1 and Host2), which interact with the central server to provide the measurements obtained.

3 Hardware requirements

3.1 Requirements of the HADES central server

The minimum requirements of hardware for a HADES server are the following:

Element	Value
Central processing unit CPU	2 GHz
RAM memory	2 GB
Hard disk	40 GB

Table 3.1: HADES server requirements

Depending on the amount of measuring points (MP) that the server will have to manage and the amount of time that the HADES central server will have to keep the measurements, those requirements increase as described in the following table:

		Storage duration				
		1 year	2 years	3 years	5 years	10 years
MP	10	16 GB	32 GB	47 GB	79 GB	157 GB
	25	105 GB	209 GB	314 GB	523 GB	1044 GB
	40	272 GB	544 GB	815 GB	1358 GB	2716 GB
	60	617 GB	1233 GB	1849 GB	3 TB	6 TB

Table 3.2: Data storage requirements

Table 3.2 gives a quick overview of the data storage requirements depending on the scale of a deployment (measured in number of measuring points MP) as well as the accumulated amount of data for certain periods of time for a fully meshed configuration. This is the requirement for the scheduled data of one measurement domain only. Dual stack measurements (IPv4/IPv6) double these requirements. If multiple measurement domains are collected on the same server, the disk space requirements of each individual domain need to be added up.

3.2 Requirements of measuring points (clients)

HADES is capable of running on any standard PC entry level hardware. To have the best available quality of measurement results, the system should be thermally stable (case fans set to specific instead of adaptive speeds, sufficient space in the case to allow for good ventilation) and if possible, any power saving features affecting operating performance (adaptive processor speed, HD suspend, …) are best disabled. The NIC is also a major factor affecting measurement results. For this it is important to consider Intel based chips and cards. To achieve the best possible results, especially concerning exact OWD values and asymmetric delay measurements, it is essential for the system to be synchronized to an external hardware clock or receiver (an alternative will be explained in section 4.4). The Meinberg GPS170PCI/PEX are in use with a majority of the systems running HADES, but other products like the significantly smaller Trimble GPS antenna also work well.

4 Pre-configuration steps

This chapter treats the previous configuration settings to be performed for a successfull installation of HADES. Therefore, these sections prepare the environment for the HADES installation configuring basic things (like firewall and NTP) that the installation process assumes ready to use.

4.1 IPv6 support on the measuring machines

The operating system, Debian in our case, supports both versions of the Internet Protocol, the IPv4 and the IPv6. Both are needed by HADES. It may be that the operating system on which HADES is to be installed does not support IPv6. If this is the case, enable this protocol and restart the machine.

4.2 Firewall configuration

This step describes how to configure the firewall in the measuring points to ensure an unobstructed communication. The configuration of the firewall is specifically applied to the range of ports used by HADES, which can be found in the configuration files located in "`/data/hades/domain_name/cfgs`". Typically the port range is from 50000 to 65535. Make sure to enable this range for a proper HADES execution (on the path previously named, the portion "`domain_name`" corresponds to the name given to the execution domain of HADES. If the domain is called "`example`", for example, that path would have the form "`/data/hades/example/cfgs`").

4.3 Connectivity test

Before any communication process and generation of public or private keys it is necessary to test the connectivity between the different sites. In order to do that, a simple traceroute command can be executed between the points that exchange information. For example, if the user wants to connect to the computer whose IP address is `192.168.0.1`, the traceroute test would be

```
]$ traceroute 192.168.0.1
```

Once the other side of the communication responds successfully it is necessary to test the SSH connection. This is accomplished by

```
]$ ssh username@192.168.0.1
```

In this command "`username`" is the name of the user who executes the current process. "`192.168.0.1`" is the IP address of the machine we want to communicate with. The first time around, it will ask you if you wish to add the remote host to a list of `known_hosts`, go ahead and say yes. After the successful completion of this test, logout from the remote machine using the following command:

```
]$ exit
```

4.4 NTP configuration

The NTP configuration is necessary for the machines that perform the measurements to be synchronized in date and time. This is done as follows:

1. The first resource to install in this section is NTP. To do this execute the following command:

   ```
   ]$ aptitude install ntp
   ```

2. Once the NTP tool has been installed, type the following command:

   ```
   ]$ vi /etc/ntp.conf
   ```

3. Include in this file the line:

   ```
   server  myntp.server.com
   ```

   From this line, the part "`myntp.server.com`" corresponds to the URL of the NTP server that HADES will use for synchronization. Change this parameter with the NTP resource that the environment has.

4. After editing the file, save the changes.

5. To start the NTP service, execute the following command:

   ```
   ]$ /etc/init.d/ntp restart
   ```

6. To determine if NTP is properly synchronized use the command:

   ```
   ]$ ntpq
   ```

```
ntpq> peer
```

The output of this command should be similar to figure 4.1.

For correct synchronization, the delay and offset values should be non-zero and the jitter value should be under 100. An example of this is listed in figure 4.1.

```
     remote           refid      st t when poll reach   delay   offset  jitter
==============================================================================
*time.nist.gov   .ACTS.           1 u    3   64  373   64.616   -8.079   0.716
+iguana.igtc.com 198.60.22.240    2 u   28   64  377    9.065   -9.429   0.628
+hydrogen.cert.u 216.218.254.202  2 u   19   64  377   35.950   -7.184   0.357
-snag.rack911.co 66.90.104.142    3 u   57   64  377   33.695   -0.893   0.645
```

Figure 4.1: NTP configuration example

It is necessary to clarify that if a machine is synchronized with an NTP server, it is mandatory that the other machines that make up the HADES environment are also synchronized with the same server. In this way, the quality of the obtained measurements is ensured. It is the responsibility of the user to include an NTP server in this configuration that provides the desired functionality. More information on NTP configuration can be found in [5].

4.5 Configuration of the Debian package manager

This section is dedicated to the configuration of `aptitude`, the Debian package manager needed in the installation process of HADES. The configuration of this tool [6] is made as follows:

1. Go to the location "`/etc/apt`"

   ```
   ]$ cd /etc/apt
   ```

2. Edit the "`sources.list`" file using the command:

   ```
   ]$ nano -w sources.list
   ```

3. Comment (using "`#`") the line that starts with "`deb cdrom:[Debian GNU/...`"

   ```
   #deb cdrom:[Debian GNU/Linux 6.0.5 _Squeeze...
   ```

4. Add the appropriate lines to your `sources.list` file. In this example, the following lines were added:

   ```
   deb    http://downloads.perfsonar.eu/repositories/deb/  stable main
   ```

5. Save the changes and quit editing the file.

6. Download the perfSONAR key. To do this, execute the following command:

```
]$ wget http://downloads.perfsonar.eu/repositories/RPM-GPG-KEY-perfsonar
```

7. Add the key to the package manager. To do this execute the following command:

```
]$ apt-get add RPM-GPG-KEY-perfsonar
```

8. Update the Debian package manager by entering the following command in the console:

```
]$ apt-get update
```

This will ensure the safe and up to date downloading of a resource required for this installation process.

4.6 Installation of SSH tools

In order to ensure communication between different parts of the HADES environment, install the Open SSH tool. This is done as follows:

- Enter the following command

```
]$ aptitude install openssh-server
```

Due to the constant need to transfer files from one point to another, the installation of this tool is more than necessary, not only for the execution of HADES but also for its installation.

4.7 Installation of rsync

Another application that is necessary to install is `rsync`. This is in charge of the synchronization of files and directories from one place to another. To install it follow the next recommendation.

- Use the following command in the console

```
]$ aptitude install rsync
```

5 Installation process

The installation process will constantly change between the client and server, this is because many times an operation depends on what takes place on the other side. However, the installation guide tries to explain first the configuration steps that the central server needs and then proceeds with the settings of the client measuring machines that the user needs to complete.

A central server configuration in HADES implies mainly the following steps:

1. HADES server package installation.
2. Installation and configuration of the database used by HADES.
3. SSH communication configuration between the measuring machines and the central server.
4. Configuration of the directory structure.
5. Central server configuration handling the hades.conf file

Once these steps have been performed on the central server, several resources will be configured on the measuring machines. To install HADES on the measuring points, the task to perform is the HADES package installation.

Finally the measuring configuration will be deployed and the execution of the `hades-analyzed` daemon will be explained.

In this context, we will proceed to show the installation of the perl modules needed to install the HADES server package on the central server.

5.1 Installation process on the server side

5.1.1 Installation of the HADES server package

Once the needed resources have been configured (section 4.5), the installation of the HADES server package can be executed.

- Type the following command:

```
]$ aptitude install hades-serverpackage.deb
```

From this command, the part "`hades-serverpackage.deb`" corresponds to the name of the HADES server package for a Debian distribution.

It could happen that the installation of a certain module needs a previous installation of another resource; in that case, it is the responsibility of the system administrator to provide or install these resources.

5.1.2 Installation of the database server

It is necessary to have a database on the central server to collect the meta data obtained by the measuring machines. This database is managed by PostgreSQL whose installation process will be accomplished inserting the following command:

```
]$ aptitude install postgresql-8.4
```

Once the database server is installed, the "`hades`" database will be created along with the user that will handle it. To accomplish this, see the next steps:

1. Add a user to the system:

```
]$ adduser myuser
```

2. Once the user has been added, assign a password with the following command:

```
]$ passwd myuser
```

3. Once the password has been assigned, change to the `postgres` user

```
]$ su – postgres
```

4. As `postgres` user, type the following command:

```
$ psql template1
```

5. Add the new user to the database along with the corresponding password

```
template1=# CREATE USER myuser WITH PASSWORD 'mypassword';
```

6. Create the database

```
template1=# CREATE DATABASE hades;
```

7. Assign all the privileges to that user upon the newly created database

```
template1=# GRANT ALL PRIVILEGES ON DATABASE hades to myuser;
```

8. Quit with the following command:

```
template1=# \q
```

9. Next, the new user along with the database will be tested. Execute the following commands:

```
$ su – myuser
```

```
$ psql -d hades -U myuser
```

After executing this, the HADES database is ready to accept any SQL query. If, at the end, the user can see the SQL execution cursor (`hades=>`), the database was successfully created.

10. Quit the database query manager with the following command:

```
]$ \q
```

5.1.3 Postgres configuration file

It is important to have a database connection in order to manage the location of the generated data. This connection is accomplished by reading a file which contains the parameters of the database to use. This section creates this file, according to the user name and database created in the previous section. To perform this configuration do the following steps:

1. Go to the location "`/etc/postgresql-common`"

```
]$ cd /etc/postgresql-common
```

2. In the `postgresql-common` folder, create a new file named "`pg_service.conf`" with the following content:

```
[hades]
dbname=hades
host=mydb.host.com
user=myuser
password=mypassword
port=5432
```

3. Finish editing the file and save the changes.

5.1.4 SSH communication configuration between the measuring machines and the central server

It is really important to have an excellent and secure communication between the measuring points and the central server. For that reason an SSH communication must be configured. This SSH communication is mainly based on two keys, one private key and one public key which must be copied to all users who want to communicate with the server [3]. The steps to complete are:

1. On the central server create the next location "`/data/hades/`"

   ```
   ]$ mkdir -p /data/hades/
   ```

2. Set "`hades`" as the owner of those folders

   ```
   ]$ chown -R hades.hades /data
   ```

3. In the "`hades`" directory, create a new folder called "`.ssh`"

   ```
   ]$ mkdir .ssh
   ```

4. In order to test the correct creation of this directory structure, go to the "`.ssh`" folder and execute the "`pwd`" command. The output should be:

   ```
   /data/hades/.ssh
   ```

5. Type the following command:

   ```
   ]$ ssh-keygen
   ```

6. This process will ask for the location of the new pair of keys being generated [4]. In this part refer to the location "`/data/hades/.ssh`"

7. Once the pair of public-private SSH keys has been generated, copy the public key to the measuring points. To do this execute the following command:

   ```
   ]$ scp /data/hades/.ssh/id_rsa.pub myuser@myipaddress:.ssh/authorized_keys
   ```

   In this command, the portion "`myuser`" corresponds to the user that manages the measuring point. The portion "`myipaddress`" corresponds to the IP address of the measuring point that will communicate with the central server.

5.1.5 Configuration of the central server directory structure

The hades-analyzed script is responsible for copying the measurements made by the measuring points to a given location on the central server; this location will be defined by the following steps:

1. On the central server go to "`/data/hades/`".

   ```
   ]$ cd /data/hades/
   ```

2. Create a directory for the domain. From the location previously explained, execute the following command:

   ```
   ]$ mkdir example
   ```

   In this example, the last part "`example`" corresponds to the name of the domain configured to do the measurements.

3. In the "`example`" directory create the directories "`data`", "`www`" and "`cfgs`"

   ```
   ]$ mkdir www

   ]$ mkdir data

   ]$ mkdir cfgs
   ```

This creates the two directories that store the measurements which, once the daemon is running, will have an internal structure updated automatically depending on the amount of time HADES is executed. For example, if HADES provided measurements on the 1st and 2nd of January of 2000, the directories created in this section would have a root directory called "2000." Within this directory there would be a subdirectory named "01" for the month of January. In this directory, two more subdirectories would appear called "01" and "02" which would contain measurements made on these dates.

5.1.6 Configuration of the HADES central server

As named above, the measurements are made by terminals that are part of a domain. In this case the domain has the name "`example`" which is configured by the "`hades.conf`" file.

There are 3 changes that have to be done in this file which are:

1. Go to the location "`/etc/hades/`".

   ```
   ]$ cd /etc/hades/
   ```

2. In that directory, there must be the configuration file "`hades.conf`". Enter the following command to edit this file:

```
]$ vi hades.conf
```

In that file there is a section dedicated to some important file locations. Go there and uncomment the following section:

```
$datadir = "$basedir/data";
$bindir  = "$basedir/bin";
$wwwdir  = "$basedir/www";
$cfgsdir = "$basedir/cfgs";
$bindir  = "$basedir/bin";
$datadir = "/data/hades/$domain/data";
$wwwdir  = "/data/hades/$domain/www";
$cfgsdir = "/data/hades/$domain/cfgs";
```

In the file there is also a section dedicated to the SSH configuration of HADES from which two parts are going to be edited. First enter the name of the user logged into the operating system on the section that says

```
user => "labor",
```

replacing the word "`labor`" by that name. For example, if the user that is using the operating system is "testuser", the word "`labor`" would be changed to "`testuser`" getting the following result:

```
user => "testuser",
```

Next, the location of the SSH private key previously generated must be specified:

```
identity_files => [
      "/data/hades/.ssh/identity",
     ],
```

changing the portion "`/data/hades/.ssh/identity`" for the location of the generated private key. If, for example, the location of such a key is "`/testuser/.ssh/id_dsa`", the line after this change should look like this:

```
identity_files => [
      "/testuser/.ssh/id_dsa",
     ],
```

Finally, the entire section should be something like this:

```
%hosts_default = (
  ssh_args => {
    user => "testuser",
    identity_files => [
```

```
      "/testuser/.ssh/id_dsa",
    ],
    protocol => 2,
  },
  bin_path => "/usr/local/bin",
  log_path => "/var/log/hades/$domain",
  pid_path => "/var/run/hades/$domain",
  cfg_path => "/etc/hades/$domain",
  dat_path => "/data/hades/$domain",
);
```

3. Hosts configuration. To do a certain measurement, two points are needed which are identified in the hosts section of the configuration file "`hades.conf`". In this file, uncomment the hosts section and make the following changes:

   - IP address. In the portion indicated by

     ```
     ip          => "1.2.3.4",
     ```

     enter the IP address of the first machine used as a measuring station.

   - Configuration of interfaces. Since the example for this installation needs only one interface per terminal, the second interface suggested in the file is deleted.

   - Second host addition. Since measurements are made between two points, a second host has to be included in this section. Copy and paste the information belonging to the first host and change carefully the number "`1`" by the number "`2`", for example, in the information of the new host, the suggested name would be "`Host1`", change this to "`Host2`" and so on. Likewise, configure the IP address of this host.

   After these changes, the section should have the following appearance (the two IP addresses are only suggestions):

```
%hosts = (
   "Host1" => {
     ip          => "192.168.1.2",
     interfaces => {
       "Host1_Interface1" => {
           shortname => "H1_I1"
       },
     }
   },
 "Host2" => {
     ip          => "192.168.1.3",
     interfaces => {
       "Host2_Interface1" => {
           shortname => "H2_I1"
       },
     }
   },
```

```
);
```

4. Routing configuration. The configuration file "`hades.conf`" has a section for the configuration of routes, uncomment it and do the following changes. In the portion that says:

```
"Host2_Interface2"      => [
       {
         packetsize => 1472,
       },
```

change the number "2" to the number "1", because only one interface per host is used. Finally, the section should look like this:

```
%routes = (
   "Host1_Interface1"       => {
     "Host2_Interface1"        => [
       {
       },
     ],
     "Host2_Interface1"      => [
       {
         packetsize => 1472,
       },
     ],
   },
 );
```

5. After editing the file, save all changes.

5.1.7 Daemon configuration in the central server

In the central server execute the following steps:

1. Go to the location "`/etc/hades/`"

```
]$ cd /etc/hades/
```

2. Start editing the file "analyzed.conf" with the following command:

```
]$ vi analyzed.conf
```

3. In the domain section (section of that file identified by the header "`domain - Configure domains that should be handled by analyzed`") write the following:

```
domain     /etc/hades/hades.conf   --updatedb
```

4. Finish the edition saving all the changes.

5.2 Installation process on the client side

Once the configuration of the central server is complete, the next step is to configure the measuring points.

5.2.1 Installation of the HADES package

Once the needed perl modules have been installed, the installation of the HADES package can be executed.

- To proceed with the installation of the package, type the following command:

```
]$ aptitude install hades-package.deb
```

From this command, the portion "`hades-package.deb`" corresponds to the name of the HADES package for a measuring point.

Again, as already described above, it could happen that the installation of a certain module needs a previous installation of another resource; if this is the case, it is the responsibility of the system administrator to provide or install these resources.

5.2.2 Directory structure of measurement machines

After the successful completion of the previous step, a directory structure has to be created to store the pid file. This structure includes the domain name that the user wants to give to the system of measurement. A domain is the set of machines that performs measurements in the network and is identified by a given name, in this case the domain name "`example`". To create this structure do the following steps:

1. Go to the location "`/var/run/hades/`"

   ```
   ]$ cd /var/run/hades/
   ```

2. In this "`hades`" directory, create a new sub directory with the domain name, in this case "`example`"

   ```
   ]$ mkdir example
   ```

3. If inside of the "`example`" directory the following linux command is typed

   ```
   ]$ pwd
   ```

   the result must be

   ```
   /var/run/hades/example
   ```

4. Go to the root location “/” and execute the following command:

```
]$ mkdir –p /data/hades/example/
```

From this command, the last part “example” corresponds to the name of the domain that will produce the measurements.

6 Configuration deployment

Once the measuring points and the central server have been configured, their configuration will be deployed in the HADES environment. To achieve this, do the following:

1. Go to the location "`/opt/hades/bin`"

   ```
   ]$ cd /opt/hades/bin/
   ```

2. Type the following command:

   ```
   ]$ perl hades-cfg-create.pl --config=/etc/hades/hades.conf --all
   ```

   After running this command, the only thing the user must do is to allow the SSH communication once. If this process requests the entry of a password, the SSH communication was misconfigured as the interaction between the different machines should not require any password. The possible solution to such problems could be to check if the public key was indeed copied in the appropriate location of the client machines.

Once this configuration has been deployed, the `hades-analyzed` daemon has to be started in order to collect the measurements. To do this, execute the following command:

```
]$ service hades-analyzed start
```

7 User perspective

Once HADES is in operation, the pre-configured measurements are produced. Section 5.1.5 explains the structure of the directories that contain the results generated by HADES. There are two directories that are of particular interest to the user. The first contains the raw data of the measurements. These are located in "`/data/hades/example/data`." The second directory contains the same data but in a processed form. These are located in "`/data/hades/example/www`." This information can be used by different tools for visualization.

If the user wants to view the results on screen, the script "`hades-show-data.pl`" can be used as follows:

1. Consider the location and name of the file to visualize. This file may hold raw data or aggregated data, i.e. it may come from the location "`/data/hades/example/data`" or from "`/data/hades/example/www`".

2. Consider the domain configuration file used to get the measurements. In this case the configuration file corresponds to "`/etc/hades/hades.conf`"

3. Go to the location "`/opt/hades/bin/`"

   ```
   ]$ cd /opt/hades/bin
   ```

4. Execute the following command:

```
]$ perl hades-show-data.pl --config=/etc/hades/hades-example.conf
/data/hades/example/www/2011/04/19/Host1_Interface1.Host2_Interface1.0.info.dat
```

As can be seen in the previously executed command, the information displayed derives from aggregated data. If the user wants to display raw data, the information must come from the "`data`" directory.

8 Bibliography

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